Case Report

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Midfoot Degenerative Arthritis and Partial Fusion After Pediatric Lisfranc Fracture-Dislocation

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Abstract

We present a case of a 10-year-old girl who sustained a Lisfranc fracture-dislocation after an all-terrain vehicle accident. She underwent open reduction and internal fixation with smooth Kirschner wires. At 5-year follow-up, she had developed functional pain and radiographic evidence of degenerative arthritis and partial fusion of her midfoot. There are several possible explanations for this outcome, including loss of reduction, traumatic or iatrogenic physeal injury, and severity of initial injury. Long-term outcomes in children with Lisfranc injuries are not well described. Our case may begin to shed light on the natural history of these injuries in the pediatric population, with the consideration of potential treatment implications and pitfalls.

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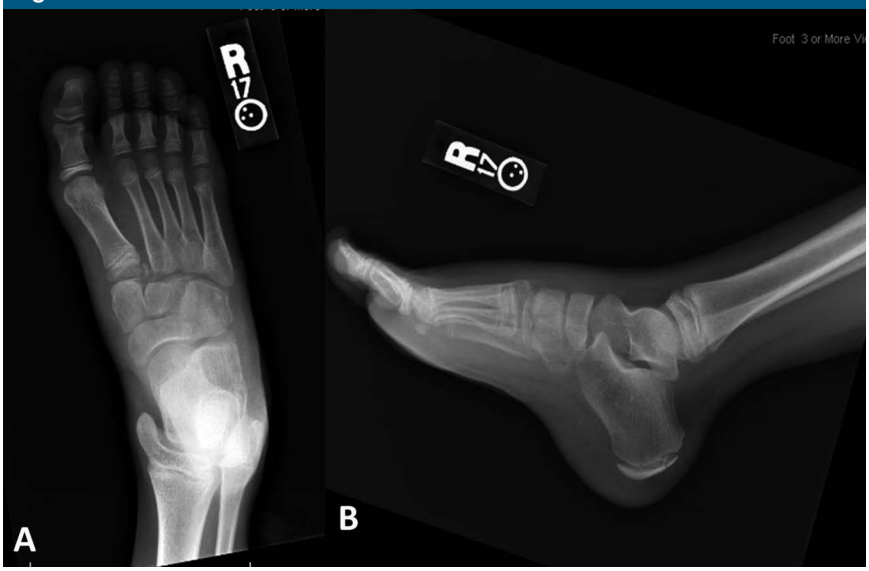
Injuries to the Lisfranc joint complex are rarely seen in the pediatric population; therefore, both treatment and outcomes have been poorly described in the literature. The exact incidence is unknown, although across all age groups, Lisfranc injuries account for <1% of fractures, with up to 20% going unrecognized at the time of the initial presentation.[1,2] These injuries occur as a result of a direct axial load or indirect rotational force on a plantarflexed foot, most of which are sports-related injuries in children, followed by falls and crush injuries.[3,4] Although short-term results in children have generally been favorable, there are few studies that adequately address long-term outcomes, especially regarding the development of posttraumatic arthritis because it is frequently described in adults. Adult studies have reported incidences of radiographic arthritis in 72% to 94% of patients, with >50% of those being clinically symptomatic.[5,6] It is unknown whether children will go on to develop arthritis at a similar rate. We present a case of a 10-year-old girl with a Lisfranc fracture-dislocation treated surgically with open reduction and K-wire fixation who went on to develop symptomatic midfoot arthritis with partial fusion identified at 5-year follow-up and discuss several possible explanations for her outcome.

Case Report

Our patient was a 10-year-old girl who hit a tree while driving an all-terrain vehicle, causing the vehicle to flip and pin her right foot between the vehicle and the tree. The patient presented to the emergency department at an outside institution and was found to have a Lisfranc fracture-dislocation characterized by

Figure 1



AP (**A**) and lateral (**B**) preoperative radiographs of the right foot. **A,** Note the widening of the Lisfranc joint with lateral translation of the rays and a fracture of the base of the second metatarsal. **B,** The lateral radiograph illustrates dorsal dislocation of the metatarsal bases.

widening of the Lisfranc joint with lateral translation of the first through fifth rays and a large fracture fragment at the base of the second metatarsal (Figure 1). A subsequent CT scan further identified a fourth metatarsal base fracture as well as multiple small cuneiform and cuboid fractures (Figure 2). Physes were noted to be open.

The patient was taken to the operating room the next day at the outside facility. Per the surgical report, attempts at closed reduction were unsuccessful, so incisions were made in the first web space and over the fourth ray. The joint spaces were swept for any fracture fragments or debris, and a Freer elevator was inserted through the incisions to manually translate the first ray medially back into the anatomic position, followed by manual reduction of the lesser rays. Fixation was achieved using a smooth 2-mm Steinmann pin placed retrograde from the first metatarsal into the medial cuneiform and navicular, a smooth 1.5-mm Kirschner wire placed retrograde from the second metatarsal into the middle cuneiform and again into the navicular, and another smooth 2-mm Steinmann pin from the metaphysis of the fifth metatarsal into the cuboid (Figure 3). No fixation was placed across the Lisfranc joint proper. The operating surgeon thought that this fixation achieved stable anatomic reduction. There was no mention as to the extent of soft-tissue injury. The patient was placed in a short leg splint and was ordered to remain non–weight-bearing for 4 weeks, at which point the pins were removed in the clinic, and she was transitioned to a short leg walking cast with weight-bearing as tolerated. No additional clinical or radiographic follow-up was available from the initial treating physician.

The patient presented to the clinic at our institution at age 15 years, approximately 5 years out from her injury. She reported doing relatively well in the interim but had begun to experience lateral hindfoot and midfoot pain in the preceding few months. The pain was relatively constant and exacerbated by walking long distances. Examination of the right foot revealed a lack of several degrees of inversion subtalar motion and prominence and tenderness over

Figure 2

Representative axial (**A** and **B**) and sagittal (**C** and **D**) CT cuts demonstrating additional fractures of the cuneiforms and cuboids.

the first tarsometatarsal joint and the medial midfoot. Radiographs showed a mild cavus foot, slightly shortened medial column, and posttraumatic degenerative changes in the near-entirety of the midfoot. Her physes were now closed (Figure 4). A subsequent CT scan further demonstrated posttraumatic remodeling of the dorsomedial midfoot with osseous fusion of the medial and middle cuneiforms with the hallux metatarsal base and partial osseous bridging of the middle cuneiform with the second metatarsal base (Figure 5).

Our patient's pain was thought to be the result of both the degenerative changes and residual deformity causing abnormal stresses across her foot. She was prescribed physical therapy for muscle strengthening as initial conservative treatment.

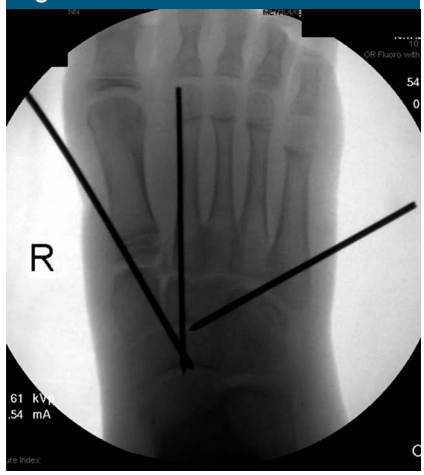
Discussion

Outcome studies regarding pediatric Lisfranc injuries are lacking. These injuries in themselves are rare and may be frequently overlooked because of skeletal immaturity and incomplete ossification making radiographic detection difficult.[4] Many children can be treated nonsurgically with closed reduction and casting, and even with surgical intervention, short-term outcomes have generally been favorable, with patients having no limitations in athletic or everyday activities.[3,7,8] However, studies suggest that long-term outcomes may be similar to those of adults. In adults, degenerative arthritis is the most common complication, with radiographic changes in 72% to 94% of patients, >50% of whom are clinically symptomatic.[5,6] Unfavorable outcomes, including pain, arthritis, decreased functional activity, and orthotic requirements, have been associated with the poor quality of initial reduction or failure to maintain an anatomic reduction.[1,5,9,10] However, degenerative changes and disability have been seen to occur even with appropriate treatment. One 10-year follow-up study found that 60% of patients with radiographic evidence of arthritis had no evidence of malalignment.[5] Similarly in children, a study of adolescent Lisfranc injuries found persistent pain and discomfort in 6 of 7 patients treated with open reduction and internal fixation, with maintenance of reduction at 26-month follow-up.[11] Several other studies have reported chronic pain in surgically treated pediatric patients as well, some with evidence of degenerative changes.[7,8,12] The full extent of radiographic and bony changes in the pediatric population, however, has not been adequately described, and long-term outcomes into adulthood are unknown.

Our patient presented at 5-year follow-up with significant posttraumatic arthritis and fusion of the medial aspect of her midfoot. An anatomic reduction had been achieved, based on the surgical report and available postoperative radiographs; however, loss of reduction is a plausible explanation for our patient's deformity and symptoms. To begin with, the fixation she received did not follow standard principles. Typically, rigid fixation is used for stabilization of the medial and middle columns in the form of screws or plates, with flexible fixation reserved for the mobile lateral column.[3,6,13] In this instance, flexible temporary K-wires were used as the sole mode of fixation. Smooth pins may have been used to protect the joint surfaces and open physes in a child, but this was potentially inadequate to hold the reduction. There was also no fixation placed across the Lisfranc joint proper or intercuneiform joints, where any subtle instability could lead to the development of arthritis and deformity.[6] Loss of reduction or instability in our patient may also be attributed to early pin removal and initiation of full weight-bearing only at 4 weeks postoperatively. In one series, pediatric patients who received surgical treatment of bony Lisfranc injuries were kept non–weight-bearing for 11 to 14 weeks, whereas those treated nonsurgically for sprains were non–weight-bearing for 7 weeks.[3] Adult patients treated surgically were typically non–weight-bearing for 6 to 8 weeks or longer as well. Despite this, one series showed that 4% of patients developed lateral subluxation after the initiation of weight-bearing, and these patients went on to develop posttraumatic arthritis.[6,13] Even if reduction was maintained after pin removal in our patient, initiating weight-bearing so soon could have disrupted a very tenuous reduction.

The development of arthritic changes may be simply due to the injury itself. As previously mentioned, posttraumatic arthritis is the most common complication of Lisfranc injuries, even in those that maintain perfect reduction.[5] The high-energy crush nature of our

Figure 3

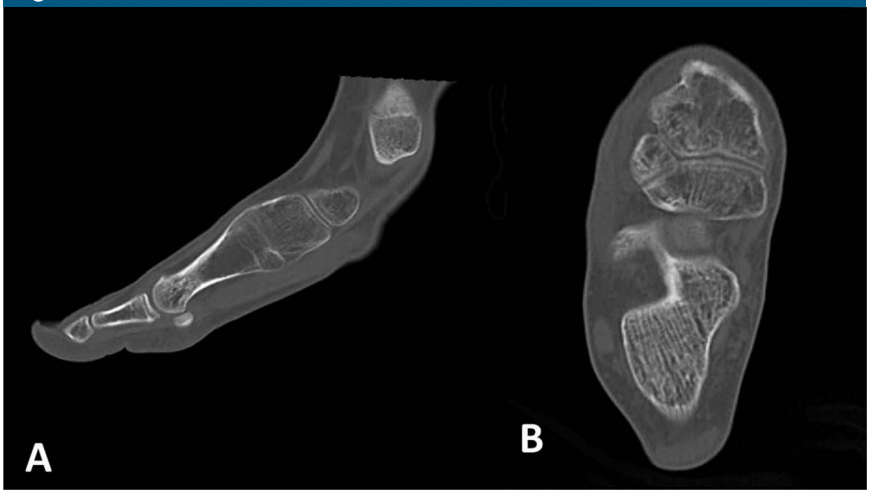


Intraoperative C-arm image of the final surgical fixation with reduction of the Lisfranc joint complex. Additional images were unavailable from the outside hospital.

Figure 4

Right foot radiographs at 5-year follow-up. AP (**A**), oblique (**B**), and lateral (**C**) views showing degenerative changes throughout the midfoot.

Figure 5



Sagittal **(A)** and axial **(B)** CT cuts demonstrating osseous fusion of the medial and middle cuneiforms with the hallux metatarsal base and partial bridging of the middle cuneiform with the second metatarsal base.

patient's injury likely caused traumatic cartilage damage as well as significant soft-tissue injury and stripping. Myerson et al[10] found that direct crush injuries did particularly poorly, with seven of eight patients scoring poor on subjective functional outcome assessments. This damage could have also been perpetuated by the need for open reduction and débridement of the joint spaces.

There are unique properties of pediatric bone that must also be considered. Our patient had open physes at the time of injury, and any damage to the physis could lead to growth disturbance and subsequent deformity. Hill et al[3] found Salter–Harris–type fractures present in 26% of patients with Lisfranc injuries and open physes, one of whom went on to develop physeal arrest. In addition, our patient had multiple attempts at closed reduction, finally requiring open reduction with soft-tissue dissection, putting the physes at further risk of iatrogenic injury. Physeal damage could have contributed to the development of our patient's shortened medial column and cavus foot. Uninjured physes may otherwise be expected to allow for some deformity correction as the patient grows. Alternatively, the healing potential of immature bone may contribute to bony overgrowth, leading to fusion and deformity in our patient's case. A study of pediatric spinal growing rods found that fusion occurred in 89% of patients in areas that had not been fused intentionally, likely because of "the proclivity of immature bone to rapidly and reliably heal fractures and, by extension, form spontaneous arthrodesis."[14] This is thought to be a consequence of periosteal stripping, whether traumatic or during surgical dissection, that

decompresses the physis and allows for overgrowth and also influences metaphyseal remodeling.[15–17] Although our patient ended up with some shortening, it is possible that overgrowth contributed to fusion in the face of damaged cartilage.

Conclusion

Lisfranc injuries in children are rare but seem to be comparable with their adult counterparts in both mechanisms and outcomes. Treatment in children should follow the same principles of rigid fixation and restricted weight-bearing as those used in adults, and excessive soft-tissue stripping during surgery should be avoided to protect the immature periosteum. As described throughout the literature, obtaining and maintaining an anatomic reduction remains a key factor in achieving good outcomes, although it cannot unequivocally prevent degenerative changes in the setting of articular cartilage or physeal damage. The development of a fusion in and of itself should be painless, but the resultant deformity may lead to metatarsalgia and adjacent joint arthritis. Even in the absence of degenerative changes, the foot should be assessed for any deformity, particularly in a child with known or suspected physeal injury. Our patient demonstrates that posttraumatic arthritis is a real concern after Lisfranc injuries in a growing foot and can lead to persistent pain, deformity, and decreased function. There is still a significant gap in the literature regarding the natural history, treatment, and outcomes of Lisfranc injuries in the pediatric population, and more long-term studies are needed to truly appreciate their sequelae.

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